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Cognitive biases, environmental, patient and personal factors associated with critical care decision making: A scoping review

Iris E. Beldhuis, MD [a,*], Ramesh S. Marapin, MD [a], You Yuan Jiang, B. Eng [a], Nádia F. Simões de Souza, BSc [a], Artemis Georgiou, BSc [a], Thomas Kaufmann, MD, PhD [b], José Castela Forte, BSc [b,c,d], Iwan C.C. van der Horst, MD, PhD [a,e]

[a] Department of Critical Care, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands
[b] Department of Anesthesiology, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands
[c] Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, University of Groningen, the Netherlands
[d] Department of Clinical Pharmacy and Pharmacology, University Medical Center Groningen, University of Groningen, the Netherlands
[e] Department of Intensive Care Medicine, Maastricht University Medical Center+, Maastricht, the Netherlands

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ABSTRACT

Purpose: Cognitive biases and factors affecting decision making in critical care can potentially lead to life-threatening errors. We aimed to examine the existing evidence on the influence of cognitive biases and factors on decision making in critical care.

Materials and methods: We conducted a scoping review by searching MEDLINE for articles from 2004 to November 2020. We included studies conducted in physicians that described cognitive biases or factors associated with decision making. During the study process we decided on the method to summarize the evidence, and based on the obtained studies a descriptive summary of findings was the best fit.

Results: Thirty heterogenous studies were included. Four main biases or factors were observed, e.g. cognitive biases, personal factors, environmental factors, and patient factors. Six (20%) studies reported biases associated with decision making comprising omission-, status quo-, implicit-, explicit-, outcome-, and overconfidence bias. Nineteen (63%) studies described personal factors, twenty-two (73%) studies described environmental factors, and sixteen (53%) studies described patient factors.

Conclusions: The current evidence on cognitive biases and factors is heterogenous, but shows they influence clinical decision. Future studies should investigate the prevalence of cognitive biases and factors in clinical practice and their impact on clinical outcomes.

1. Introduction

Clinical decision making entails the diligent use of current evidence, taking into account both clinical expertise and patients' wishes. [1] In critical care settings, such as the intensive care unit (ICU) or the emergency department (ED), the decision making process is a high-risk enterprise. Although critical care is widely recognized to be associated with declining mortality rates of patients with critical illness, many patients are subjected to potentially life-threatening errors. [2-4] Therefore, further investigation into the factors involved with decision making is warranted.

In critical care settings, clinicians need to make accurate decisions promptly in stressful situations characterized by a high degree of uncertainty. These situations could ultimately compromise the rational decision making process and shift this process towards relying on clinical experience and personal judgment. However, personal judgment is considered to be influenced by the individual's cognitive biases and personality characteristics. [5] Additionally, stress and fatigue factors are known to influence judgment and, in turn, decision making. [6]

Heuristics, defined as useful mental strategies aimed at solving problems quickly and frugally, may sometimes fail to assess complex processes accurately. This, in turn, can result in cognitive biases, which can subsequently lead to errors in judgment and the clinical reasoning process. [7] Many kinds of heuristics and cognitive biases exist that influence individuals, including anchoring, availability, and confirmation bias. [8] Importantly, cognitive biases are increasingly recognized as a cause of medical errors. Multiple studies confirm that these cognitive

* Corresponding author at: Department of Critical Care, University Medical Center Groningen, Hanzeplein 1, 9713 GZ Groningen, the Netherlands.
E-mail address: i.e.beldhuis@umcg.nl (I.E. Beldhuis).

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biases significantly affect the decision making process, leading to diagnostic inaccuracies and medical errors. [5,8,9]

Information on the influence and interaction of cognitive biases and factors affecting physician decision-making is scarce. [9-12] For example, there has been limited research on the actual decision making process and factors relevant to critical care physicians in charge of admission decisions. [5] Greater awareness and understanding of the impact of cognitive biases and factors in this setting hopefully stimulates reflective practices and subsequently improves patient outcomes. Therefore, in this present scoping review, we tried to summarize evidence on the association between cognitive biases and possible factors with decision making in a critical care setting.

2. Material and methods

2.1. Study process

Before searching the available literature for evidence on cognitive biases and factors associated with decision making in critical care, we did not know which kind of studies would be retrieved. Therefore, we performed a systematic search and decided on the structure to summarize the evidence after all studies were found and read by various authors.

2.2. Search strategy

The MEDLINE search was performed in November 2020. The search included MeSH terms such as: "intensive care" or "critical care" and "decision making" or "clinical decision making" or "cognitive bias" and "physician" and "qualitative research". The search was developed in consultation with an information specialist to ensure a high-quality process. The search strategy is available in Supplementary File 1.

2.3. Study selection

Potential eligible studies had to meet the following inclusion criteria: [1] articles were published in 2004 or after, [2] were full-text articles written and published in English, and [3] reported (clinical) outcomes or factors regarding decision making [4] specifically within the intensive care or emergency care. Studies were excluded if they focused on [1] end-of-life decision making or [2] decisions regarding discharge or [3] admissions to the intensive care units or [4] involved patients under the age of 18.

2.4. Data extraction

After all studies were retrieved, the studies were read by various authors. After discussion, it was decided to extract data and to describe the findings. For the description of the biases derived in the studies we choose to present a brief explanation of each bias based on a previous study by Crosskerry et al. [8]

Data extraction and initial assessment were done by two authors (NS, YYJ), and all disagreements were resolved by consulting a third author (IB). The extracted information included author name(s), year of publication, the country where the study was conducted, number of study participants, level of physician's experience, study design and methods, type of cognitive bias, type of personal factors, type of environmental factors and data quality. We discuss the most commonly studied biases and factors. Biases are described according to the description by the authors of the identified studies.

2.5. Data quality

The Newcastle-Ottawa Scale (NOS) was used to assess the quality of included studies. [9] The Cochrane Collaboration recommends the use of the NOS as a quality assessment tool for nonrandomized studies. [13] The NOS scores studies on three broad perspectives: the selection of the study groups; the comparability of the groups; and the ascertainment of either the exposure or outcome of interest for case-control or cohort studies, respectively. One or two stars (points) are awarded for each of these three domains. A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories, and a maximum of two stars can be given for comparability. In line with previous studies, the study was considered high quality when awarded with 7 to 9 points; 5 to 6 points were considered moderate quality; and 0 to 4 points were deemed low-quality studies. [9,14]

3. Results

A total of 2756 records were yielded in the initial search, and five additional studies were located and considered by looking at the reference lists of the relevant studies. After screening the titles and abstracts, 90 studies remained. After a full secondary screening of the remaining articles and excluding the irrelevant studies ($N = 60$), the final number of included studies was 30, comprising 2506 physicians (Fig. 1).

3.1. Data quality

All identified studies were designed as observational studies of heterogenous design, e.g. survey, interview, medical records abstraction, or vignette-study. The studies evaluated cognitive biases, environmental or personal factors influencing decision making in the emergency or intensive care department. Interpreting the data quality with the NOS, the majority of studies ($n = 15$, 50%) were low quality, 13 (43%) studies ranked as moderate, and 2 (7%) studies ranked as high quality (Supplementary File 2).

3.2. Study characteristics

Details regarding physician and study characteristics are summarized in Table 1. Seventeen out of the 30 studies described information regarding physician's gender and/or age. Most of the physicians were male, and the mean age varied from 29 to 48 years (Table 1). Regarding the study methods, a survey was the most frequently used ($n = 13$), either alone (n = 1) or in combination with clinical vignettes ($n = 7$), medical record abstraction ($n = 3$), observations (n = 1), or with biological samples (n = 1). Two studies used only a clinical vignette. In addition, interviews ($n = 6$) and observations ($n = 2$) were conducted, or interviews were conducted in combination with observations (n = 3). Two studies used a grounded theory method. One study used observational descriptive analysis. Fig. 2 provides an overview of the most common biases and factors found in these studies, while Fig. 3 describes the number of biases and factors described per article. A conceptual model depicting the biases and factors is shown in Fig. 4.

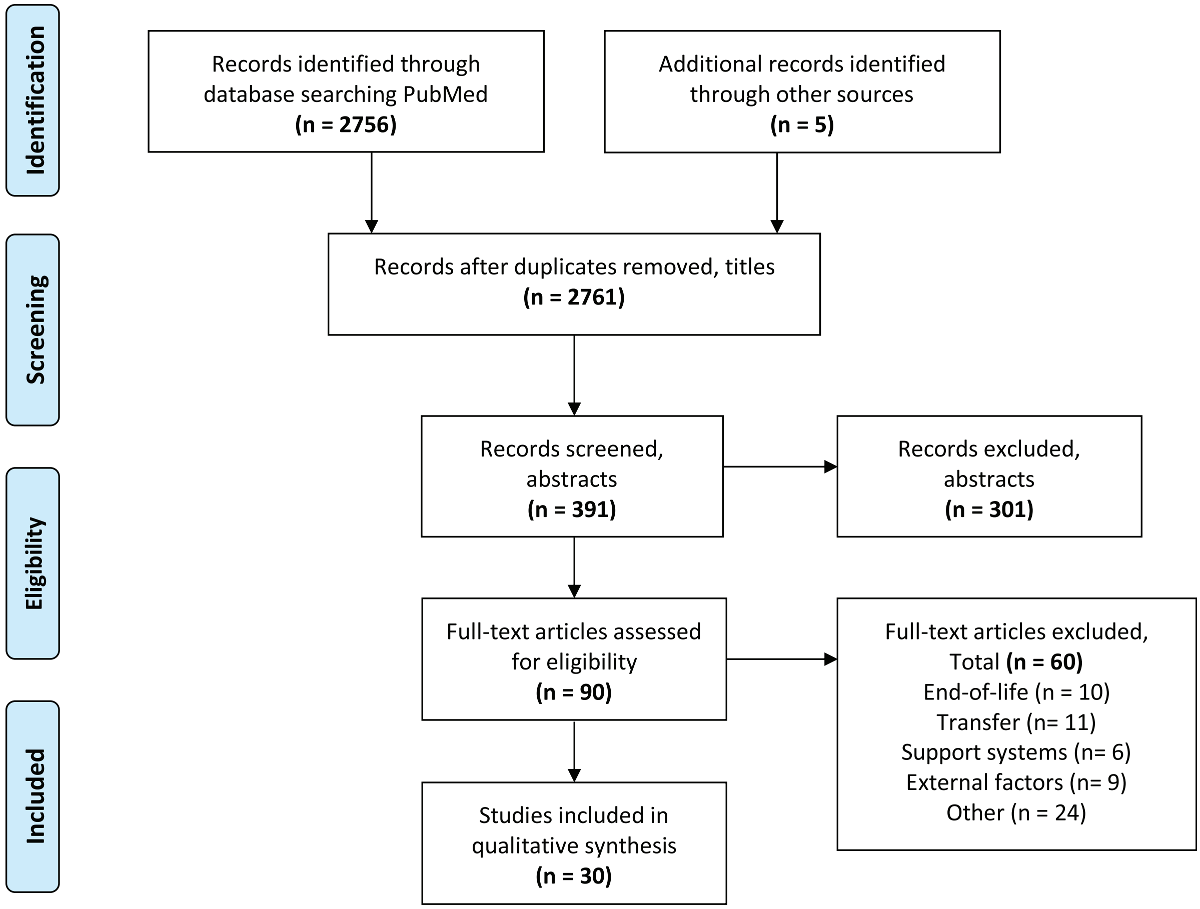
3.3. Cognitive biases in decision making

Of the 30 included studies, 6 (20%) described cognitive biases, which comprised omission and status quo bias, implicit and explicit bias, outcome bias, and overconfidence bias. [9,15-19] A brief explanation of each bias is depicted in Table 2, adopted from Crosskerry et al. [8] Fig. 2 provides an overview of the most common biases.

3.3.1. Omission and status quo bias

The first study used two vignettes (one on pulmonary embolism and one on sepsis) in a group of 125 pulmonologists the suboptimal management strategy was chosen when an omission option was present that allowed preservation of the status quo (71% vs. 53%, $p = 0.048$; 50% vs. 29%, $p = 0.016$, respectively). A second study used a vignette on tube feeding, in this same group of 125 pulmonologists, and found that the omission option was not significantly associated with the decision to prescribe tube feeding. [16] A third study, with 36 clinicians,

PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

Fig. 1. PRISMA Flow diagram of articles that were included and excluded.

conducted focus groups and found, especially among the junior doctors, that reluctance in making decisions (e.g., omission bias) was closely related to the belief that causing harm to the patient was worse than allowing harm to happen by omitting action or failing to initiate treatment. [15] They concluded from an interview with a junior doctor that this overwhelming desire to do no harm appeared to stem from undergraduate training and the emphasis placed on being aware of one's limitations. [15]

3.3.2. Implicit and explicit bias

A first study on the measure of explicit bias among 175 internal medicine and 35 ED residents, found that both expressed an equal

Table 1
Characteristics of studies included in the review.

Authors*	Year of Publication	Country	Number of participants	Type of participants	Methods	Male (n, (%))	Age (categories [n] or [±SD or range])
Aberegg	2005	United States	125	Specialists (Pulmonology)	Survey + case vignettes	108 (86)	47.8 (±10)
Arnetz	2017	United States	28	Residents (ED)	Survey, biological samples	20 (71)	29.4 (±2.3)
Ballard	2008	United States	203	Specialists (ED)	Survey + case vignettes	147 (72)	–
DeKeyser	2016	Israel	42	Specialists (ICU), nurses (ICU)	Grounded theory methodologies	–	–
Farmer	2006	England	18	Specialists (ED, Geriatrics, Internal medicine)	Interviews	–	–
Green	2007	United States	220	Residents (ED, Internal medicine)	Survey + case vignettes	124 (60)	29.05 (±2.8)
Gupta	2004	United States	587	Specialists (ED)	Survey + case vignettes	499 (85)	<40 (188) 50–60 (200) 50–60 (170) > 60 (29)
Haider	2014	United States	248	Specialists (Trauma Surgery)	Survey + case vignettes	202 (80)	<30 (15) 30–34 (55) > 35 (181)
Halvorsen	2009	Norway	21	Specialists (Anaesthesiology)	Observations + Interviews	12 (57)	45.6 (35–60)
Henderson	2015	Australia	124	Specialists (ICU)	Survey + case vignettes	–	–
Isbell, Tager	2020	United States	50	Specialist (ED), Resident (ED)	Observations + Survey	32 (64)	39.1 (±6.4)
Isbell, Boudreaux	2020	United States	45	Specialist (ED), Resident (ED)	Interviews	33 (74)	40 ± 8
Kajdacsy-Balla Amaral	2014	Canada	29	Specialists (ICU), Fellows (ED), Residents (ED)	Observations	–	–
Khorram-Manesh	2019	Sweden	18	Specialist (ED), Intern, Resident	Interviews	11 (61)	36.2 (±8.7)
Kissoon	2020	United States	NA	Specialists (ED), Residents (ED), Medical Officers (ED)	Observational descriptive analysis	–	–
Kruser	2019	United States	NA	Specialists (ED), Residents (ED)	Medical record abstraction + Interviews	–	–
Laxmisan	2007	United States	6	Specialists (ED)	Observations + Interviews	–	–
McKenzie	2015	United States	17	Specialists (ICU)	Observations	13 (76)	40.1 (37–52)
Neville	2017	United States	36	Specialists (ICU)	Survey + medical record abstraction	–	–
Okafor	2016	United States	119	Specialists (ED), Residents (ED)	Survey + medical record abstraction	–	–
Pamplin	2020	United States	11	Specialists (Burn ICU), Residents (Burn ICU)	Case vignettes	–	–
Parshuram	2015	Canada	47	Residents (Internal Medicine, Anesthesiology, Surgery and Emergency Medicine) and Specialists (ICU)	Survey + medical record abstraction	–	25–30 (31) 30–25 (10) > 35 (4)
Pelaccia	2016	France	15	Specialists (ED)	Interviews	–	42 (±5)
Saposnik	2013	Canada	111	Residents, specialists (Internal Medicine, ED, Neurology)	Survey + case vignettes	70 (63)	40 (±12)
Seidlein	2020	Germany	5	Specialists (ICU), Residents (ICU)	Observations + Interviews	3 (60)	42.2 (30–57)
Tallentire	2011	Scotland	36	Specialists and residents	Grounded theory methodologies	–	–
VanKerkhoff	2019	United States	NA	Specialist (ICU)	Interviews	–	–
Walzl	2019	Scotland	15	Specialists (ED)	Interviews	8 (53)	–
Weng	2011	Hong Kong	315	Specialists (ICU)	Survey	162 (53)	<40 (249) 40–49 (54) > 50 (9)
Young	2007	United States	15	Residents (Surgery, ED)	Case vignettes	11 (73)	30 (26–33)

preference towards Caucasian and African American patients ($p = 0.36$). They also reported that Caucasian and African American patients were equally cooperative in medical procedures ($p = 1.00$). [17] In contrast, implicit bias among the physicians existed, favoring Caucasian above African American patients ($p < 0.01$). In addition, implicit stereotypes existed among the physicians, showing that African American patients were less cooperative in general ($p < 0.001$) and with medical procedures ($p < 0.001$). As physicians' pro-Caucasian implicit bias increased, so did their likelihood of treating Caucasian and not African American patients with thrombolysis ($p = 0.009$). [17] A second study with 248 trauma surgeons found that 73.5% of the physicians demonstrated an unconscious preference towards Caucasians among trauma surgeons. Also, 90.7% of the physicians demonstrated an implicit preference towards upper social class persons. [18] However, in this study, these biases were not significantly associated with clinical decision making.

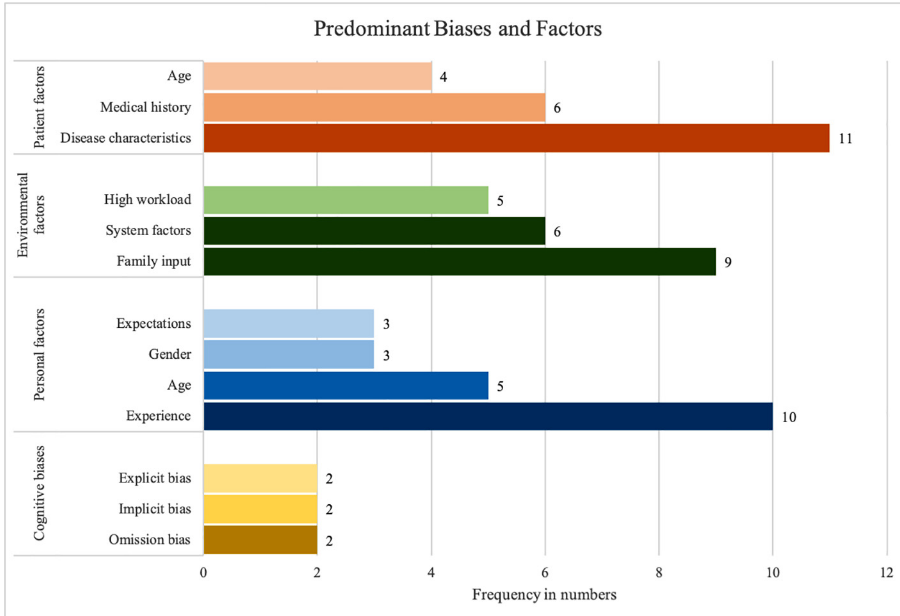


Fig. 2. Predominant biases and factors included in our study.

3.3.3. Outcome bias

One study demonstrated among 587 ED physicians that the quality of care was affected by the patient outcome. [19] They found that the quality ratings were the highest when the outcome was good and low when the outcome was bad. Regarding intermediate quality, outcome bias tended to shift by one quality step (e.g., from good to average). The outcome bias effect was smaller for scenarios for which care was unambiguously good or bad. There were no differences in score by age, years of practice, clinical hours per week, participation in quality improvement, or medicolegal activities. Finally, they found no evidence that outcome bias was concentrated in individual physicians.

3.3.4. Overconfidence bias

One study evaluated, among others, factors influencing clinicians' estimation regarding the probability of stroke outcomes in 1415 patients. [20] They found that clinicians with expertise in stroke care performed poorly in estimating the probability of crucial clinical outcomes associated with ischemic stroke. Only 1 in 6 clinicians' estimation for the primary outcome was within the 95% CI of the actual observed outcome.

3.4. Personal factors in decision making

Of the 30 included articles in this study, 19 (63%) described personal factors as associated with decision making. A total of 26 different factors were identified; the most commonly cited factors were experience (n = 10), age (n = 5), gender (n = 3), and physician expectations (n = 3). Eight (27%) studies described experience as a factor in decision making. [15,21-27] Two (7%) studies reported no association between experience and decision making outcomes. [20,28] Four (13%) studies found

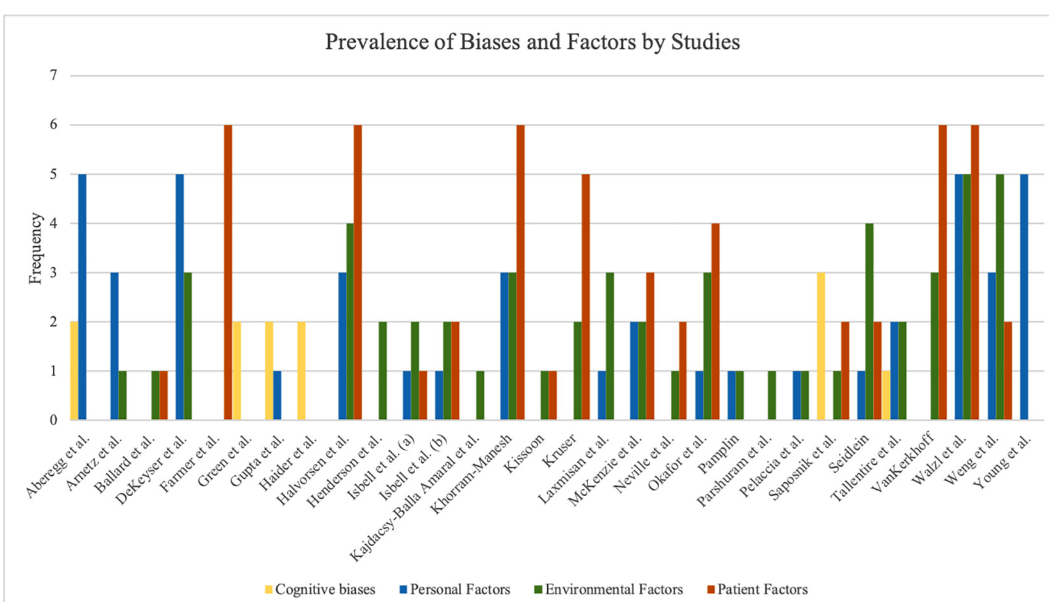


Fig. 3. Prevalence of biases, personal factors, environmental factors, and patient factors for each study.

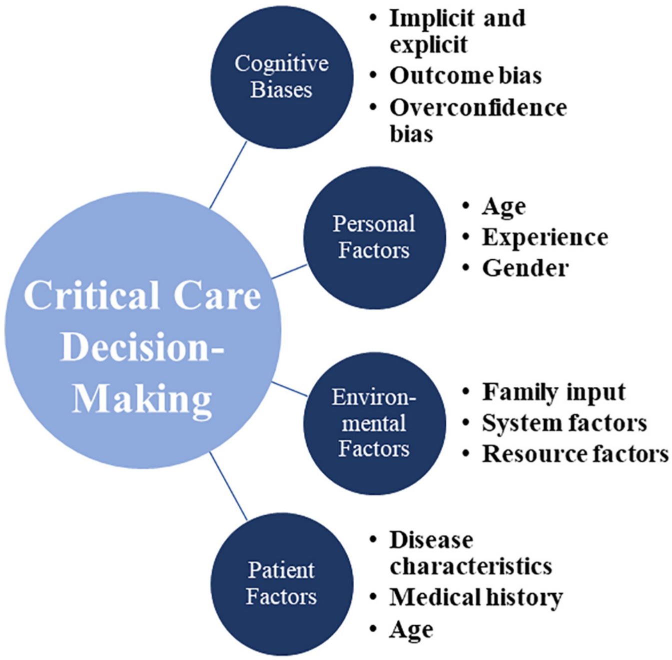


Fig. 4. Conceptual model for the biases and factors involved in clinical decision making in the critical care context.

Table 2
Brief description of cognitive biases.

Cognitive Bias	Reference	Brief description
Omission bias	[16]	Preference for omission/inaction which can lead decision-makers to choose the risks and benefits of the status quo even when the relative risks (RR) and benefits from changing the status quo through action are objectively superior.
Status quo bias	[16]	Preference for active intervention where decision-makers may inappropriately judge harms by action as less severe as harm by doing nothing.
Implicit bias	[17]	Unconscious preference for, e.g. a Caucasian race.
Explicit bias	[17]	Conscious preference for, e.g. a Caucasian race.
Outcome bias	[19]	The propensity to assign blame more readily when the outcome is bad.
Overconfidence bias	[20]	Decisions based on erroneous predictions may result in incorrect patient and family expectations, and potentially inappropriate treatment, counseling, or discharge planning.

no association between age and decision making. [16,20,24,28] One study found that younger age was associated with increased total daily decisions in the ICU. [29] In one study, most respondents described that they did not feel that their gender influenced the decision making process. [21] In the context of dyadic relationships in shared decision making, gender was described as affecting decision making. Another study found that the female gender was associated with increased total daily decisions. [29] One study reported no significant association between gender and decision making outcomes. [16] Regarding physician expectations, all three (10%) studies reported an association with decision making. [23,30,31] A list of other less frequently described factors related to decision making, such as responsibility ($n = 2$) and medical specialty (n = 2), are mentioned in Table 3.

3.5. Environmental factors in decision making

Environmental factors were identified in 22 (73%) of the 30 articles included in this study. The most cited environmental factors which appeared to influence the decision making were family input, system factors, medical hierarchy, resource factors and high workload. Specifically, family input was discussed as an environmental factor in nine studies [23,25,28,29,32-35], while system factors were discussed in six studies. [21,25,27,29,36-39] Medical hierarchy was identified as a factor by four studies. [15,21,27,31] Resource factors were presented as an environmental factor by four studies also. [23,27,40,41] Finally, the decision aids were mentioned by four studies. [26,34,35,42] Other factors identified and analyzed were a high workload in five studies [20,30,37,40,43], health economic factors [44], presence of a personal values report, which is a patient views assessment tool [33], communication style [37], inefficient processes [40], inadequate handover [40], horizontal relationships [21], and experiential knowledge. [22] A detailed list of all the environmental factors included in our study can be found in Table 3.

3.6. Patient factors in decision making

Among the 30 studies included in this review, only 16 (53%) studies reported patient-related factors influencing critical care decision making. [20,23,28,29,31,32,40,44,45] We distinguished 24 different patient factors, with disease characteristics ($n = 11$) being the most frequently discussed (Table 3). [20,23,25,28,31,32,34,35,40,42,45]

Disease characteristics include, but are not limited to, test results, patient symptoms or complaints, (atypical) illness description by patients, patient state of health, patient clinical condition, or prognosis. Overall, the process of gathering information about the patient's clinical condition (chronic) disease process, prognosis, or functional capacity, was discussed to be crucial before any decision regarding treatment initiation could be made. [23,28,32]

The second most cited patient-related factor regarding decision making was the patient's medical history ($n = 6$). [20,23,25,31,34,45] Additional patient-related factors concerning decision making included age ($n = 4$) [23,25,40,45], patient's wishes (n = 4) [23,34,35,44], communication barriers ($n = 3$) [25,40,45], patient engagement (n = 3) [34,35,40], prognosis (n = 3) [27,35,41], and other factors mentioned in Table 3.

4. Discussion

In the present scoping review, we found that current evidence on cognitive biases and factors associated with decision making is heterogenous. From 30 studies we could subcategorize factors into personal factors, environmental factors, and patient factors. At least one bias or factor was identified in each of the studies. Biases identified in these studies consisted of omission bias [15,16], status quo bias [16], implicit and explicit bias [17,18], outcome bias [19], and overconfidence bias. The most common personal factors described were experience, age, gender, and physician expectations. These were family input, nighttime cross-coverage, medical hierarchy, insufficient resources, high workload, and patient load for environmental factors. Finally, 'disease characteristics' was the most common patient factor encountered. We think that our description of current evidence is a first step to acknowledge these biases and guide more homogenous studies on cognitive biases and factors associated with decision making in critical care.

With regards to the biases that may affect critical care decision making, we found that studies differed in study design, subjects studied, and results found. Furthermore, studies were of different quality. The two studies regarding the optimal treatment choice or initiating treatment showed omission bias was present among the physicians. [15,16] The two studies on implicit and explicit bias regarding patient race showed incongruent findings. [17,18] The study on outcome bias described that physicians rated the quality of care different with knowledge of patient outcome. [19] The study on overconfidence bias stated that physicians' predicted outcomes differed from actual observed outcomes . [20]

Table 3
Outcomes of studies included in the review.

Authors	Year of Publication	Cognitive biases	Personal factors	Environmental factors	Patient factors	Data Quality*
Aberegg	2005	Omission bias, status quo bias	Age, race, gender, practice affiliation, socioeconomic status	–	–	2
Arnetz	2017	–	Fatigue, TNF-α, expectations	High workload	–	4
Ballard	2008	–	–	Healthcare costs	Patient wishes	3
DeKeyser	2016	–	Gender, experience, knowledge, personality traits, availability	Horizontal relationships, medical hierarchy, system factors	–	5
Farmer	2006	–	–	–	Communication barriers, age, gender, ethnicity, medical history, disease characteristics	3
Green	2007	Implicit bias, explicit bias	–	–	–	5
Gupta	2004	Outcome bias, hindsight bias	Work culture	–	–	2
Haider	2014	Implicit bias, explicit bias	–	–	–	5
Halvorsen	2009	–	Expectations, roles and responsibility, medical specialty	Information and documentation, work culture, medical hierarchy	Age, self-induced illness, disease characteristics, gender, ethnicity, religion	5
Henderson	2015	–	–	Presence of Personal Value Report, family input	–	2
Isbell, Tager	2020	–	Emotions	System factors, family input,	Patient behaviors (positive, angry, mental health)	6
Isbell, Boudreaux	2020	–	Emotions	Hospital factors, system factors	Patient behaviors, specific patient populations	6
Kajdacsy-Balla Amaral	2014	–	–	Nighttime cross-coverage	–	6
Khorram-Manesh	2019	–	Physician values and beliefs, work culture, experience	System factors, hospital factors, family input,	Medical history, disease characteristics, psychosocial factors, existential factors, patient age, patient language	6
Kissoon	2020	–	–	Decision aid	Disease characteristics (on echo)	4
Kruser	2019	–	–	Decision aid, family input,	Disease characteristics, resuscitation status, patient engagement, patient wishes, medical history	6
Laxmisan	2007	–	Multitasking skills	System factors, high workload, handoffs	–	5
McKenzie	2015	–	Age, gender	Nighttime cross-coverage, family input	New patient, patient location, time since admission	7
Neville	2017	–	–	Family input	Disease characteristics, patient values and beliefs	4
Okafor	2016	–	Cognitive factors (faulty information verification,faulty information processing, faulty data gathering, faulty knowledge)	High workload, resource factors, handoff	Disease characteristics, medical history, communication barriers, patient engagement	4
Pamplin	2020	–	Experience	Decision aid	–	5
Parshuram	2015	–	–	High workload	–	7
Pelaccia	2016	–	Experience	Horizontal relationships	–	4
Saposnik	2013	Overconfidence bias, anchoring bias, confirmation bias	Age, medical specialty, experience	High workload	Age, disease characteristics	6
Seidlein	2020	–	Experience	System factors, resource factors, time, medical hierarchy	Prognosis, resuscitation status	5
Tallentire	2011	Omission bias	Experience, roles and responsibilities	Medical hierarchy, stress management	–	4
VanKerkhoff	2019	–	–	Family input, time, decision aids	Disease characteristics, prognosis, patient insights, patient engagement, patient values and beliefs, patient wishes	1
Walzl	2019	–	Expectations, accepted for higher care, physician values and beliefs, personality traits, experience	Resource factors, time, family input, information and documentation, work culture	Disease characteristics, medical history, age, functional capacity, quality of life, patient wishes	4
Weng	2011	–	Culture, experience, age	Family input, legislation, resource factor, horizontal relationship, healthcare costs	Disease characteristics, socioeconomic status	2
Young	2007	–	Age, experience, hours of sleep, medical school attended, honor society attended	–	–	4

* =Newcastle Ottawa Scale.

We found several discrepancies regarding personal factors identified in these studies. First, while eight studies described the experience as a factor in decision making [15,21-27], two studies reported no association between experience and decision making outcomes. [20,28] This discrepancy could signify a yet ambivalent relationship between experience and decision-making, heterogeneity in the definition of "experience" could explain this as well (i.e., the definition of experience is not universal; the actual amount of experience for each respondent could potentially differ between studies). Furthermore, only one out of the eight studies discussing age as a personal factor reported an association with decision making (i.e., higher ages were associated with more daily decisions in the ICU). It should be noted that while experience and age are noted as separate factors here, we recognize the overlap between these concepts.

Regarding gender, the evidence is also equivocal here. Where one study's respondents report that their gender did not influence the decision making process [21], evidence for such an association was found in another study, where female gender was associated with an increased amount of total daily decisions. [29] Finally, studies describing physician's expectations on decision making all reported an association between expectations and decision making outcomes. [23,30,31] This is not surprising, as having certain expectations about, e.g., the difficulty of a shift can reasonably be predictive of making diagnostic errors, as described in Arnetz et al. [30] Having described these findings in more detail, the small sample size of studies needs to be recognized.

Concerning the environmental factors described in our study, several interesting effects on clinical decision making were presented. The presence of family was identified by nine studies, making it the most common environmental factor. [23,25,29,32-35,39,41] The family's views on the patient's treatment were almost universally considered of little importance, with one study reporting that the vast majority of physicians (70.2%) deemed them inappropriate when patients were trying to voice their own opinions on treatment. [33] Another study proposes family input only as a guide when the patient is unable to express their views. [23] Furthermore, families' opinions were identified as having an insignificant impact on decision making. [29]

On the contrary, Neville et al. reported that, when the family was not guided appropriately by physicians, there was an adverse effect on the suitability of the chosen treatment. [32] Though, patient views on treatment, though, were considered of utmost importance in one study [33], which reported that the personal values report, which is a patient views assessment tool, was found useful by almost all their study participants. In the same direction, another study supported that the more the patient's wishes were followed, the more appropriate the chosen treatment proved to be. [32] Also the availability or the use of decision aids has a strong impact on the decision making process, in four studies it affected the confidence of the physician positively in making the decision. [26,34,35,42] Two studies supported paradoxically that exposure to night cross-covering was associated with lower ICU mortality, while night shift was not found to affect the number of the decisions significantly made the day after by the intensivist. [29,36] System factors, hospital factors, high workload and resource factors were both linked to having adverse effects on efficient decision making. High workload was analyzed by several studies, one study found that residents who were working a 24-h shift had greater severity of their worst symptom related to tiredness and a greater number of symptoms with moderate severity [43] and another that excessive workload caused over one-third of system-related errors in the emergency department. [40] Patient load, on the other hand, was identified as a factor increasing stress by Arnetz et al., while Laxmisan et al. mentioned that the more the patients per attending physician/resident per shift, the more the need for complex communication between clinicians. [30,37] Communication style, what is more, was reported to be positively influenced (more detailed) by better relationships between colleagues (horizontal relationships). [21] Last but not least, a medical hierarchy was presented to be of importance, with four studies reporting that junior doctors were reluctant to ask for help [15] and to express their opinions towards senior doctors [31], while at the same time they felt obliged to use patronizing language when presenting patient cases.

Several differences affecting outcomes regarding patient-factors were found in this review. One study states that when test-results were alarming, they were of significance in the decision making process but were less important than the patient's illness description, associated symptoms, and risk factors when being negative. [45] Another study found that in the individual decision making process, the patient's health state was evaluated differently among specialists. [31] Okafor and colleagues found that atypical presentation was the most significant contributor to diagnostic errors by emergency department (ED) physicians. [40]

The patient's medical history was explored diversely in the studies included, with Farmer stating that when physicians co-construct the medical history with the patient rather than retrieving objective historical elements it influences their decision making as it constitutes an important element of judgment. [45] Farmer et al. also concludes that people have little insight into their own cognitive process, so studies of physicians working 'in the wild' would be helpful to further elaborate on the cognitive process. [45] Khorram-Manesh and colleagues describe that patients with a complex medical history and or unclear diagnoses remain longer at the emergency department, due to physician's uncertainty in the management of these patients. [25]

There were variations in how age was associated and discussed, with one study describing that the importance of chronological age was underestimated in treatment decisions in intensive care, while biological age was mentioned as a decisive factor. [31] Another study explains that clinicians see age as an essential factor influencing outcomes and, therefore, their actions. [20] However, Walzl et al. found that clinicians felt that age should not impact decision making but acknowledged that their decisions affected young patients. [23]

Due to the heterogeneity of underlying causes for cognitive biases, prevention can be an intensive undertaking, and research has found mixed results of those efforts. Perhaps, mitigation of cognitive biases starts with creating awareness among the workforce. [46] Clinicians and the management should become aware that the human brain is fallible and that it continuously tries to infer missing information by combining new sensory inputs with past experiences and expectations. [47] After awareness has been established, various undertakings could occur, such as explicit process descriptions, speaking groups, exploration of personal causes, decision making training, and cognitive training. [48-52] Another potential aid in the prevention of cognitive biases is the use of clinical decision support systems. [53,54] These algorithms constitute an essential tool to help mitigate cognitive biases in critical care, by accumulating the vast amount of data collected in the ICU and processing them into actionable information. Different studies have already shown these systems enable clinicians to better guide treatment, predict and manage. ICU admissions and discharge, and dynamically assess risk. [55-57] Current available evidence on these aids need to be validated in clinical settings first. At the moment these cognitive aids are not supported by evidence to reduce cognitive bias.

Our results should be viewed in the context of the study limitations. This scoping review used a strict study selection and methodology to address the inter- and intra-observer variability. By working through each research step in the process with at least two authors, the risk of inter- and intra-observer variability was reduced. Despite our comprehensive effort, some studies might not have been identified, as some did not have a clear description in the title and/or abstract. The search was also limited to the MEDLINE database; perhaps a more extensive search in more databases could result in more findings. However, due to the large quantity of the search strategy, it would not be feasible to analyze even more articles with due diligence. Furthermore, the strict search based on the inclusion and exclusion criteria (English language and publication date <15 years) may lead to a reduced number of articles used for this scoping review. Additionally, at the review-level, reporting bias and the lack of critical appraisal of included studies were present. There is no clear distinction between a factor or bias; it is somewhat ambivalent. Some articles described the biases and factors clearly [21,23,32], while others described it unsystematically. [19,48] To overcome these issues, we compared the outcomes with an equivalent of other studies to deduct the similarities and differences. Overall, the studies that are included for this scoping review seemed to be stemmed from low quality. By applying the Newcastle-Ottawa Scale (NOS), we measured the quality of the studies accurately as possible. Regardless of the low quality, it is essential to mention that many studies included large sample sizes of caretakers and the studies have global representativeness. A scoping review's emphasis is on the comprehensive coverage rather than on a particular standard of evidence.

5. Conclusions

To conclude, cognitive biases and several important factors, including environmental, personal, and patient-related factors, affect individual critical care physicians in their decision making process daily. The factors influencing decision making in critical care settings were physician experience, family presence, and disease characteristics. However, more research is required to determine the prevalence of cognitive biases and factors, and their potential impact on clinical outcomes in further research. More knowledge on decision making could eventually help to mitigate cognitive biases in critical care.

Disclosures

All authors have reported that they have no relevant relationships to this paper's content to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcrc.2021.04.012.

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